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He closes his preface to this third report with an earnest request that all parties actively engaged in any work relating to plant pathology would forward him separates of their published articles.—C. O. TOWNSEND.

NOTES FOR STUDENTS.

PROTOPLASMIC CONNECTIONS in a large number of plants belonging to all groups from algae to flowering plants have been studied recently by Keinitz-Gerloff.[8] Previous investigations have already made it seem probable that protoplasmic connections are universally present in the spermatophytes; the present work shows that the connections are as uniformly present in the lower groups, the filamentous algae perhaps being an exception. In such algae, however, each cell is so independent in nutrition and reproduction that the absence of connections need not occasion surprise. The suggestion is made that the connections may not be derived wholly from the *Hautschicht*, but that they may have a core of trophoplasm surrounded by *Hautschicht*. The theory that the connections conduct stimuli and materials is supported, but the reviewer believes that the whole subject needs further investigation.—CHARLES J. CHAMBERLAIN.

THE PHYSIOLOGY of adjustment to poisons dissolved in the medium has been made the subject of a contribution by Pulst.[9] He worked with the Mucor, Aspergillus, Botrytis, and Penicillium. The effect of a number of kations was determined, among them Cu, Zn, Hg, Ni, Co, Cd, Pb, etc. The anion SO_4 was usually used, but some others (*e. g.*, $C_4H_4O_6$, CN, NO_3, Cl, etc.) also appear in the tables. Penicillium withstands a much higher concentration of these substances than do the other three moulds. The effect of a salt upon the plant appears to depend in great measure upon the electrical charge of the kation, also in part upon the action of undissociated molecules. As was known before, a gradual increase in concentration brings about an accommodation to much stronger solutions than could be withstood if the change were made suddenly. Copper ions appear to be unable to penetrate the protoplast of Penicillium, though the other protoplasts studied are readily permeable to them.—B. E. LIVINGSTON.

ACCORDING TO SHIBATA,[10] the fertilization of the egg and polar nuclei of *Monotropa uniflora* is practically the same as has been observed in all the forms in which double fertilization is known. The sperms are elongated when they enter the embryo sac, and become more nearly spherical as fusion progresses.

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[8] Neue Studien über Plasmodesmen. Ber. Deutsch. Bot. Gesell. **20**: 93–117. *pl. 4*. 1902.

[9] PULST, C., Die Widerstandsfähigkeit einiger Schimmelpilze gegen Metallgifte. Jahrb. Wiss. Bot. 37: 205–263. 1902.

[10] SHIBATA, K., Die Doppelbefruchtung bei *Monotropa uniflora* L. Flora **90**: 61–66. 1902.

The second male cell comes in contact with the upper polar nucleus, while the lower polar nucleus comes in contact with the male cell and upper polar nucleus and the three fuse simultaneously. The endosperm nucleus divides before the oospore shows signs of division. Only in Naias, as reported by Guignard, does the oospore divide first, but even here, when division of the endosperm begins, it proceeds with much greater rapidity than in the embryo. The two deeply staining bodies reported by the reviewer in the end of the pollen tubes of Silphium and Erigeron were observed and figured in Monotropa, but their origin was not determined. The article is illustrated with ten excellent figures. — W. J. G. LAND.

HAUPT[11] adds somewhat to our knowledge of gland action by a recent paper from the Leipzig laboratory. Working with extrafloral nectaries, he finds that the secretion of sugar begins at a certain age of the nectary and with relatively high atmospheric humidity, *i. e.*, with checked transpiration. After it is started, a rise in humidity increases the amount of water excretion, but that of sugar remains constant. Usually when secretion is stopped, the already secreted sugar fails to be resorbed, but in some cases resorption occurs. In Vicia and certain Euphorbiaceae the red and yellow rays of the sun's spectrum are necessary for the secretion of sugar, and the secretion is resorbed in darkness, or in blue and violet light. Plants deprived of CO_2 exhibit the light reaction even after many days; thus the response is not connected with the photosynthetic process. There exists in all plants experimented upon a minimum temperature for the beginning of secretion, but after the process has begun it goes on slowly even somewhat below this minimum.— B. E. LIVINGSTON.

THE EMBRYOLOGY of the Araliaceae has just been described at some length by Ducamp.[12] He finds, as a rule, only one archesporial cell in the nucellus of the ovule. This cell gives rise to a tapetal cell and the megaspore mother cell. The mother cell may develop directly into the embryo sac, or may first give rise to an axial row of three or four megaspores, the lowest of which usually germinates, although one of the middle cells occasionally develops at the expense of those above and below. In *Fatsia Japonica* a case is figured in which the middle cell of an axial row of three had divided longitudinally. In another case, after the mother cell had divided transversely, both daughter cells had divided longitudinally. A case in which two mother cells in a single nucellus had divided in this manner gives the nucellus a very sporangium-like character, and in the opinion of the writer strengthens the theory that the nucellus is the homologue of the sporangium of the cryptogams. The statement is made that the division of the nucellus of the mother cell sometimes takes place without the formation of cell walls, but the figures are very small and may bear another interpretation. Double fertilization was looked for, but nothing definite was found. The development of the embryo and the appearance of tissue systems are described in detail.—CHARLES J. CHAMBERLAIN.

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[11] HAUPT, HUGO, Zur Secretionsmechanik der extrafloralen Nektarien. Flora **90**: 1–41. 1902.

[12] DUCAMP, L., Recherches sur l'embryogénie des Araliacees. Ann. Sci. Nat. Bot. VIII. **15**: 311–402. *pls. 6–13.* 1902.

ITEMS OF TAXONOMIC INTEREST are as follows: C. V. PIPER (Bull. Torr. Bot. Club **29**: 221–226. 1902), in his sixth paper entitled "New and noteworthy northwestern plants," describes new species of Antennaria (2), Madia, Synthyris, Astragalus, and Philadelphus.—J. C. ARTHUR (*idem* 227–231), in his second paper entitled "New species of Uredineae," describes new species of Uromyces (2), Puccinia (4), and Uredo (2).— P. A. RYDBERG *idem* 232–246), in his eighth paper entitled "Studies on the Rocky mountain flora," describes new species of Stanleya (2), Thelypodium (2), Lepidium (2), Roripa (3), Lesquerella, Physaria, Cardamine, Sophia (2), Draba (7), Geranium (2), Oxalis, and Lupinus (4).—ALICE EASTWOOD (Proc. Calif. Acad. Sci. III. Bot. **2**: 241–252. *pls. 23–24.* 1902) has published nine new species of Ribes from the Pacific coast, and also a key to the 57 species of that region.—C. D. BEADLE (Biltmore Bot. Studies **1**: 51–137. 1902) has published 104 new species of Crataegus from the southeastern states.— F. E. BOYNTON (*idem* 138–142) has published new southern species of Amorpha (2) and Coreopsis (2).—T. G. HARBISON (*idem* 158) has published a new Trillium from Alabama.—C. D. BEADLE (*idem* 159–163) has published new southern species of Philadelphus (3) and Prunus (2).— Dr. WEBER (Bull. Soc. Nat. d'Acclim. de France, May 1902), in his second paper entitled "Études sur les Opuntia," has discussed *O. leucotricha*, the "duraznillo" of the Mexicans, and also the six other species of the section CRINIFERA, one of them (*O. Gosseliniana*) being new.— E. L. GREENE (Ottawa Nat. **16**: 35–39. 1902) has described new northwestern species of Actaea (3), Delphinium, Cerastium (3), Carduus, Erigeron (2), Pentstemon, and Lappula.—J. M. C.

PROFESSOR F. O. BOWER[13] has called attention to the imperfect sporangia of pteridophytes, notably those at the base and apex of the strobili of lycopods, in which group 94 species were examined. In certain forms there is no line of demarcation between the strobilus and the vegetative part of the plant, any leaf being a potential sporophyll. The other extreme is to be found where the strobilus is made up of sporophylls whose form and arrangement differ from the foliage leaves. All degrees of transitional stages exist. In all species quite constantly abortive or imperfect sporangia were found at the base, apex, or in sterile zones of the strobilus. The author discusses these incompletely developed sporangia "in order that these facts may have their true weight in the general discussion of vegetative and fertile regions of the primitive leafy sporophyte." It is possible to look upon an imperfectly developed part as either upon the up-grade (nascent) or on the down-grade (evanescent) of development. These terms "nascent" and "evanescent" may be applied to either the ontogeny or the phylogeny. As an advocate of the antithetic theory of alternation of generations, Professor Bower does not accept the recapitulation theory. Hence the question of priority in the history of descent cannot be settled summarily by the sequence in the ontogeny. Neither an infinite number of transitional forms, nor experimentally the conversion of a sporophyll into a foliage leaf proves anything more than an intimate relationship between the two. It in no way settles phylogenetic priority.

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[13] Imperfect sporangia in certain pteridophytes. Are they vestigial? Annals of Botany **15**: 225–267. 1901.

A clue, the writer urges, may be obtained from the bryophytes. A comparison of the most primitive sporangium (Riccia) with more complex types indicates the intercalation of a seta before the spores are formed, and leads one to conclude that the seta does not precede spore development phylogenetically, but that in more complex capsules the spore development is retarded by an intercalated stage; in short, progressive sterilization and intercalation of vegetative parts takes place to provide for the growing demand for nutrition. In the genus Lycopodium a comparison of closely related forms and a study of the individual part has led the author to believe that the history of development is analagous to that of the bryophytes. By progressive sterilization the basal sporangia have become functionless and vestigial. The incomplete sporangia at the apex of the cone he regards as supernumerary, not in the same category with those at the base. Selaginella, Isoetes, and Equisetum are also discussed from the same standpoint. The author concludes that although abortive parts are less common in plants than in animals, and have played a less important rôle in theories of plant morphology than in zoology, they should not be left out of account altogether.—FLORENCE M. LYON.

F. E. LLOYD has filled an important gap in our knowledge of the essential morphology of angiosperms by his studies on the Rubiaceae. The first part, dealing chiefly with *Vaillantia hispida*, was issued August 26, 1899, and was noted in this journal.[14] The second part[15] now issued deals with numerous other forms, so that the conclusions are derived from a study of twenty-three species representing nine genera of Rubiaceae. In all forms, excepting species of Houstonia, the nucellus is very much reduced, not being distinguishable except at early stages, when it is a cap-like layer of cells covering the archesporium. As usual among the Sympetalae, the very small nucellus is associated with a massive integument. In Houstonia the ovules have no integument, the archesporium becoming deeply imbedded by growth of the nucellar tissue. In the Spermacoceae an outgrowth derived from the funiculus is described as a "strophiole," and contains the vascular supply of the ovule. Throughout all the forms the archesporium contains seven to fifteen cells, the larger numbers occurring among the Galieae. Each spore mother cell forms the usual tetrad of four megaspores in linear series, but rarely are there any walls. In some cases two or more megaspores begin to function, sometimes in the same tetrad; ordinarily, however, the innermost megaspore of a central tetrad finally becomes the single embryo sac. The behavior of the embryo sac among the Galieae and in Diodia is quite remarkable, since it breaks through the nucellar cap and passes into the micropyle. The antipodals give evidence of more or less activity, among some of the forms one enlarging decidedly; among others division occurring so that there are four to ten antipodals; while in other forms they are ephemeral. Among the Galieae there is a remarkable suspensor, the cells elongating laterally or lateral branches arising and penetrating among the endosperm cells. It is another very interesting illustration of the various forms of haustorial development in connection with the embryo.

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[14] BOT. GAZ. **29**:292. 1900.

[15] LLOYD, FRANCIS E., The comparative embryology of the Rubiaceae. Mem. Torr. Bot. Club **8**:27–112. *pls. 8–15*. 1902.

In the first division of the mother cell the spindle is multipolar in origin, and no centrosomes are to be found. In Crucianella and Asperula, whose cytological features were carefully studied, the reduced number of chromosomes is ten and twelve respectively; but after counting a large number of cases the writer believes that the number is not constant. In Asperula, in a late anaphase of the first division, the second longitudinal splitting of the chromosomes is already quite evident. In Crucianella this splitting takes place in the telophase. After the first division the daughter nuclei pass into a somewhat incomplete resting stage, no nucleolus being formed, and the nuclear membrane being quite indistinct. This division is heterotypic, but the second division, and also the divisions that occur during the germination of the megaspore, are homotypic. Judged from a cytological standpoint, the divisions which give rise to the row of four cells are true tetrad divisions, and the four cells are spores.

The memoir closes with a description of the behavior of the pollen tube in Diodia and Richardsonia, special stress being laid upon the determination of the course of the pollen tube.—J. M. C.

PROFESSOR GOEBEL has certainly earned the thanks of all students of evolution, and specifically of hybrids and plant-breeding, by reprinting the remarkable paper of Gregor Mendel on "Versuche über Pflanzen-hybriden.[16]

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[16] Flora **89**: 364–403. 1901. In a note of historical interest, Dr. Goebel states that the paper presented in 1865 and published in 1866 was long unknown to botanists. DeVries, Correns, and others made the re-discovery and pointed out its great value. It is now even more accessible, having found a place in Ostwald's "Klassiker der exakten Wissenschaften" as No. 121, published by Wilhelm Engelmann, 1901.

Artificial pollination to produce variations in color and the striking regularities that appeared in hybrid forms from the same crosses were the special features of Mendel's work, which had for its object a study of the development of hybrids in their offspring. Mendel is not surprised at the new discovery of a generally valid law for the formation and development of hybrids, considering the great difficulties involved. No previous work, as he points out, was carried on in such a manner as to allow of the determination of the number of the different forms in which the offspring of hybrids appear, and to show that these forms can be classified with certainty in the several generations and the mutual numerical conditions determined; although such comprehensive study is the only way finally to solve a question which, in the evolution of organic forms, is of no mean importance.

The reasons for selecting the genus Pisum are given, and from thirty-four varieties of peas twenty-two were selected for the experiments, after a two-year test had shown them to be constant in their offspring. To study the changes in the inheritance of different characteristics, and to determine the law according to which these differences appear in the succeeding generations, were the objects of the experiment, and the latter object would constantly divide itself into as many experiments as there were constant different characteristics in the plants selected. Of such characteristics there were studied: the differences in the shape of the ripe seed; differences in the color of the endosperm, and in the color of the seed coats; differences in the form of the ripe pods and the color of the unripe pods; differences in the position of the flowers; and finally differences in the length of the axes.

Earlier experiments had shown that hybrids[17] were not, as a rule, exact averages of the parents. Often certain prominent characteristics appeared to such an extent that another characteristic would be rare or even absent. This was the case with the Pisum species. Mendel classifies such characteristics as dominating and recessive ("dominirende und recessive"). All experiments showed that it was immaterial whether the dominating characteristic was in the seed parent or in the pollen parent. Of the differing characteristics, the following were dominant: (1) the round or roundish seed with or without shallow depressions; (2) the yellow color of the endosperm; (3) the gray, gray-brown, or leather-brown color of the seed-coat, in combination with a violet reddish flower and reddish spots in the leaf axils; (4) the simple domed form of the pod; (5) the green color of the unripe pods in combination with the green color of the stems, the ribs of the leaves, and the calyx; (6) the distribution of flowers along the stems; (7) the length of the longer axis.

The first generation of hybrids, in addition to the dominating characteristics, showed also the recessive characteristics in their peculiarities, and in the decisively apparent average of 3:1, *i. e.* of four plants of this first generation three had the dominating and one the recessive character. This was true without exception for all characters which were considered. Intermediate forms were not noticed in any of the experiments. As an example may be mentioned that in the first experiment, from 253 hybrids 7324 seeds were had in the second year. Of these, 5474 were round or roundish, and 1850 were angular and wrinkled, resulting in a ratio of 2.96:1. In the second experiment, 258 plants gave 8023 seeds, of which 6022 were yellow, and 2001 green, giving a ratio of 3.01:1. The other ratios were for (3) 3.15:1, (4) 2.95:1, (5) 2.82:1, (6) 3.14:1, (7) 2.84:1. For the whole series the ratio was 2.98:1, or practically 3:1.

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[17] Hybrids (Hybriden) is used in the paper in the sense of "cross."

The second generation showed that these forms, which in the first generation had exhibited the recessive character, did not vary in this character. They remained constant or fixed. Of those with the dominant characteristic in the first generation, two parts gave offspring which in the ratio of 3:1 carry the dominant and recessive characteristics, *i. e.* the same relation as the hybrid forms; and only one part remained constant with the dominant characteristics. In the first experiment of this series, 565 plants from round seeds of the first generation gave 193 with none but round seeds—and were therefore constant in this characteristic,—372 gave round and angular seeds in the ratio of 3:1. The number of hybrids was therefore to the number of constants as 1.93:1. In the second experiment the relations were 3:1 and 2.13:1. In the succeeding experiments the number of plants was reduced, but the ratios as a whole remained constant, although showing greater variations.

The ratio 3:1 in the first generation becomes for all the experiments 2:1:1, distinguishing the dominating characteristic both as an original and a hybrid character. As the members of the first generation come directly from the seed of the hybrids, it is now seen that the hybrids of each two differing characteristics gave seed of which one-half again developed the hybrid character, while the other gave plants which remained constant and exhibited in equal parts the dominating and recessive character.

The first and second experiments carried through six generations, the third and seventh through five, and the fourth, fifth, and sixth, through four generations, show the ratio of 2:1:1, although beginning with the third generation only a small number of plants was used. If, then, A represent one of two constant characteristics, *e.g.* the dominating one, the recessive designated by a, and Aa the hybrid form in which both characteristics are united, there results the expression $A+2Aa+a$ for the developmental series of the offspring of hybrids with two differing characteristics. The tendency of hybrids to revert to the parental type is explained by this expression. In the case of two and three differing characteristics, it was found that the hybrids were closer to such parents as had the greater number of dominating characteristics. Designating the seed parent by AB, the pollen parent by ab, the round seed by A, the angular seed by a, the yellow endosperm by B, and the green endosperm by b, then the relations as found by experiment were expressed by the term $AB+Ab+aB+ab+2ABb+2aBb+2AaB+2Aab+4AaBb$, or a combination of $A+2Aa+a$ and $B+2Bb+b$. For three differing characteristics the combination was $A+2Aa+a$, $B+2Bb+b$, $C+2Cc+c$.

With some further experiments, Mendel then concludes that the offspring of hybrids, in which several essentially different characteristics are united, are the members of a series of combinations in which each two differing characteristics are combined in a developmental series. This at the same time proves that the behavior of two differing characteristics in hybrid combination is independent of other variations in the two parents. Developing his mathematics still further, he shows that if n designate the number of characteristic differences in the two parent plants, then 3^n is the number of the terms in the combination, 4^n the number of the individuals, and 2^n the number of the combinations that remain constant. The foregoing results led to attempts at experimental proof of the theory that the ovary of the hybrid contains as many germ cells and the anthers as many pollen cells as constant forms of combination are possible. This was shown for peas, as indicated in the results.

Experiments with *Phaseolus vulgaris* and *P. nanus* gave results corresponding to those already mentioned, but only partially corroborative results were had with *Phaseolus nanus* as seed parent and *P. multiflorus* as pollen parent. In this latter experiment the changing color caused some interesting observations and speculations on the theory of this change in accordance with the results developed in other experiments.

The concluding pages deal with the work of Kölreuter and Gärtner, especially along the lines of Mendel's experiments, and finally with a discussion of the changing of one variety into another by means of artificial pollination.—G. N. LAUMAN.